TAL TECH

Sustainable Scheduling for Ultra Massive Machine Type Communication using NOMA in 6G O-RAN

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Traditional RAN Vs. Open RAN (O-RAN)

Traditional RAN (Radio Access Network)

- Protocol stack that runs on proprietary hardware.
- Radio Unit and BBU are connected via proprietary interfaces.
- Single vendor provides both Radio Unit and BBU.

Open RAN

- Standardized SW-centric approach based on commoditized hardware.
- Open standard interfaces with multi-vendor RU and CU/DU ecosystem deployment
- Open source. AI/ML-based platform designed for non and near-RT network functions (RIC).

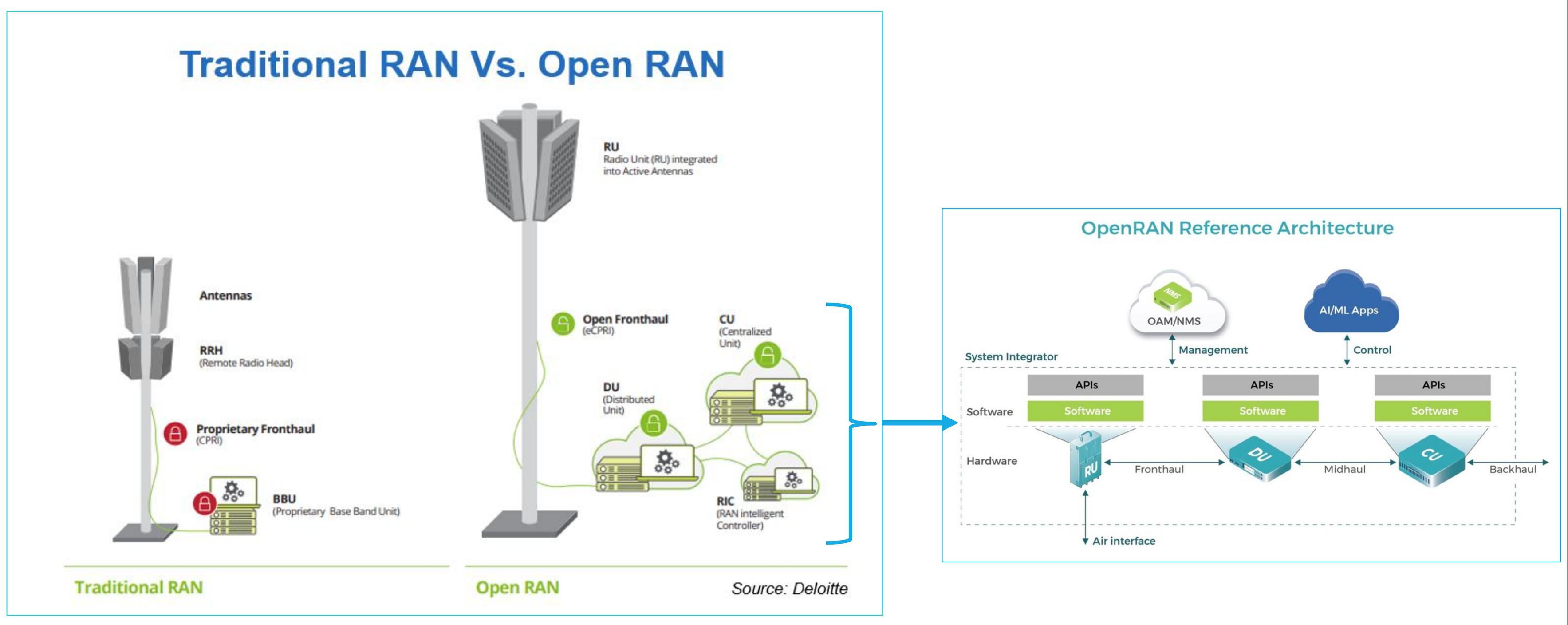

Fig 1: Traditional RAN Vs. Open RAN (O-RAN)

O-RAN Architecture

Open RAN can be broadly divided into the following three elements:

1. Open interfaces that combine RAN equipment from a variety of vendors. i.e., Front Haul, O1, E1, A1, E2, F1-U, F1-C.
2. Disaggregation that enables hardware and software inside RAN equipment to be separated, i.e., Control Unit(O-CU), Distributed Unit(O-DU), Radio Unit(O-RU).
3. Intelligent control that optimizes and automates RAN operation. i.e., near Real-Time RAN Intelligent Controller(nRT-RIC), and Non-Real Time RAN Intelligent Controller (Non-RT RIC).

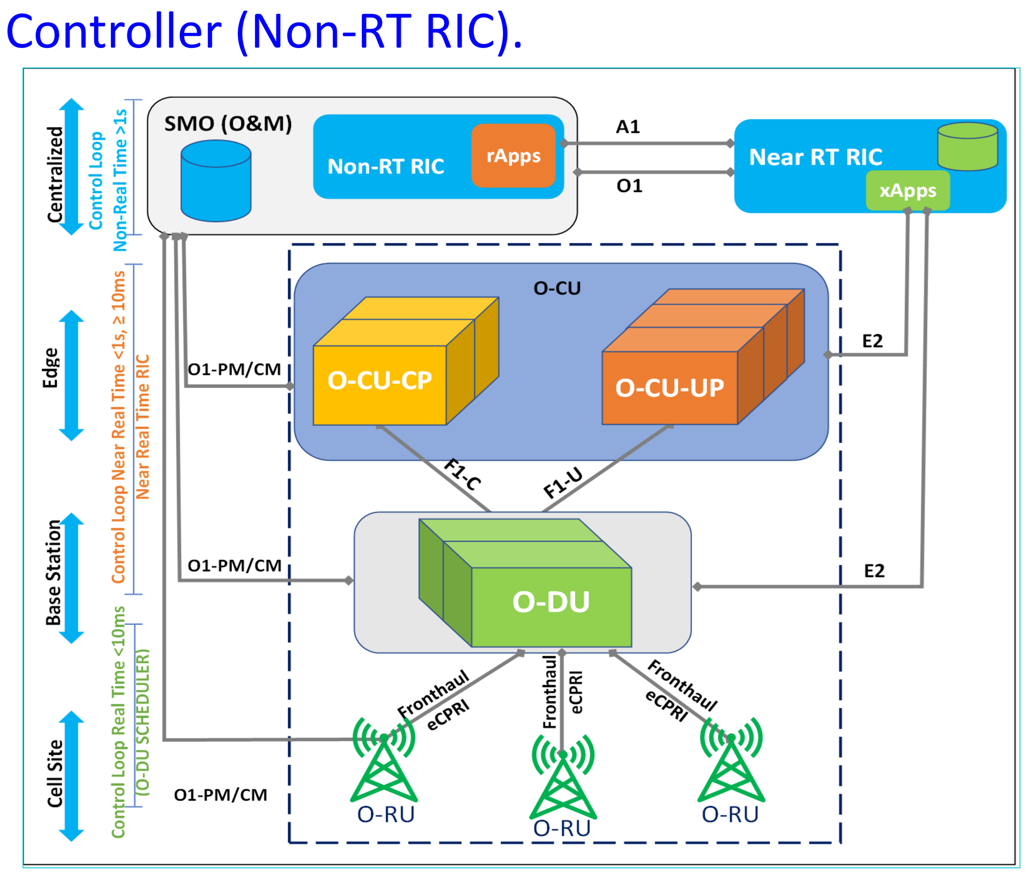

Fig 2: O-RAN Architecture

Fig 3: O-RAN Use Cases

O-RAN BENEFITS AND CHALLENGES

Fig 4: O-RAN: Benefits

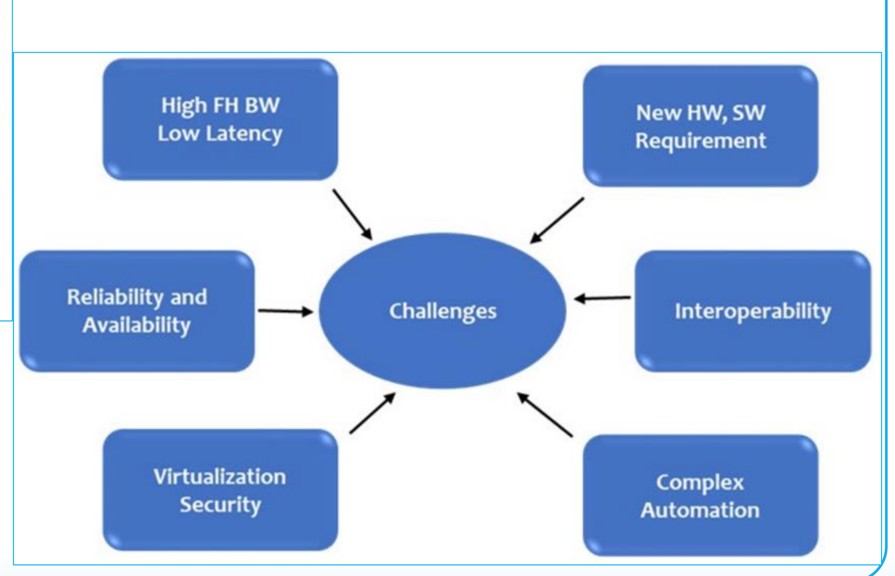

Fig 5: O-RAN: Challenges

RESEARCH CASE STUDY

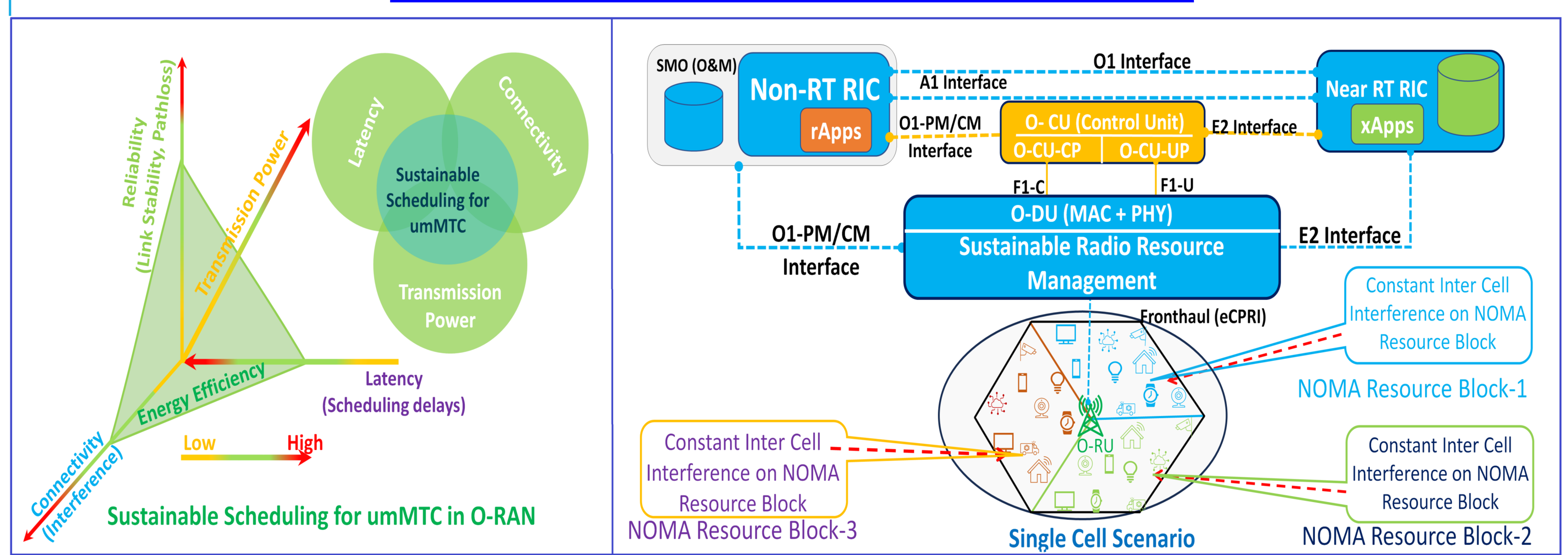

Fig 6:Sustainable scheduling for massive machine-type communication in 6G and Single Cell Scenario

Algo. 1 :Proposed Algorithm for Sustainable Scheduling

Require $BW, M, P_{max}, G_u^r, P_n, Area, ISD, G_{AC}, G_Us$
User Equipment creation ▷ Set $u_s \leftarrow G^r_{u_s,s}$
Initialize $P_u^r = P_{max}$ and Compute CSI
Step 1: Resource Allocation Calculate $\mathcal{SINR}$ as in (Eq.3)
while NumSector **do**
  for Usrs in TotUsr **do**
    Calculate $Int_s^r = M * N_{AC} * P_{max} * G_{AC}$
    Calculate $IntU_s = Sum(IntU_s)$
    Calculate $RtU_s = Sum(RtU_s)$
    Calculate $EEU_s = Sum(EEU_s)$
  end for
  Best Combination $IntU_s min, RtU_s max$
  Best Combination $EEU_s max$
end while
Require $IntU_s min$, $RtU_s max$, $EEU_s max$
for CHGain in $IntU_s min$ **do**
  for Usr in NOMARB **do**
    Calculate $IntU_M = Sum(IntU_M)$
    Calculate $RtU_M = Sum(RtU_M)$
    Calculate $EEU_M = Sum(EEU_M)$
  end for
  Best Combination $EEU_M max, RtU_M max$
  Best Combination $LatU_M min$
end for
Assign RB $EEU_M max, RtU_M max, LatU_M min$
return $RtU_M max, EEU_M max, LatU_M min$
Require $RtU_M max, EEU_M max, LatU_M min$

Step 2: Power Allocation Require $P_u^r = PowMat$
while UsrChGain **do**
  for Power in PowMat **do**
    for Us in NOMAUsr **do**
      if $\mathcal{SINR} \geq \mathcal{SINR}_{min}$ **then**
        Calculate $RtU_M = Sum(RtU_M)$
        Calculate $EEU_M = Sum(EEU_M)$
      end if
    end for
  end for
  Calculate Power $RtU_M max, EEU_M max$
  return $RtU_M max, EEU_M max, Pwr_{alloc}$
end while

Proposed Algorithm and RESULTS

Table 1: Energy Efficiency comparison among different algorithms in terms of connection density

Connection Density $users/sqm^2$	Proposed SRRS MTCN's EE (bits/J)	ESAP NOMA's EE(bits/J)	RAAP NOMA's EE(bits/J)
300	4.6840e+08	3.5740e+08	3.1008e+08
250	3.1947e+08	1.0260e+08	2.2324e+08
200	2.3534e+08	6.8010e+07	1.4403e+08
150	1.5080e+08	2.8169e+07	8.7012e+07

Table 2: Latency comparison among different algorithms in terms of connection density

Conn Density $users/sqm^2$	Proposed SRRS MTCN's Latency (msec)	ESAP NOMA's Latency(msec)	RAAP NOMA's Latency (msec)
300	118.317	446.75	1.19sec
250	72.02	294.49	543.96
200	34.40	118.317	249.49
150	25.04	74.99	153.16

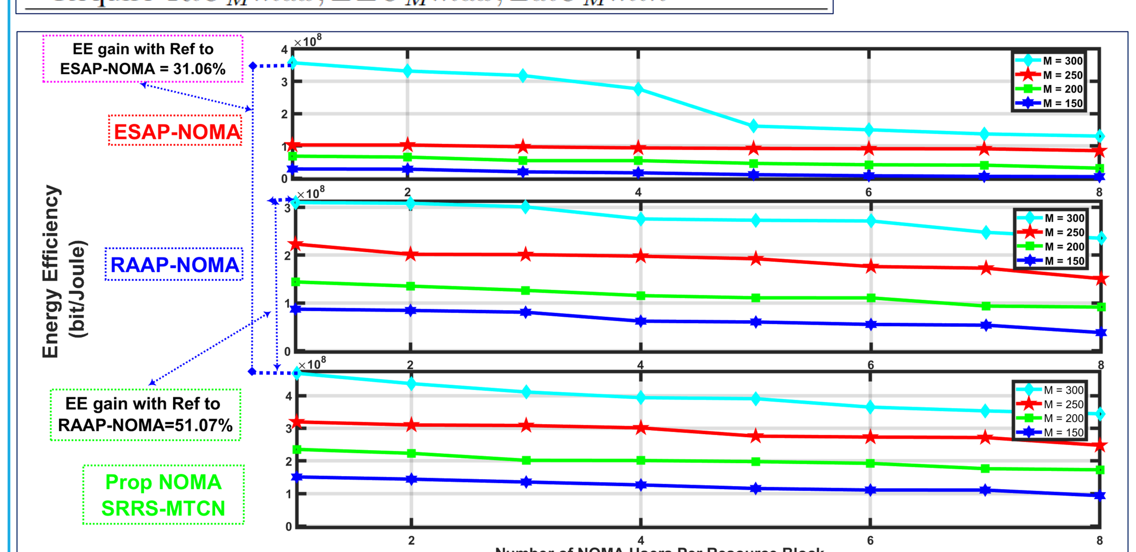

Fig 7: System Energy Efficiency with different number of umMTC devices Mmux per resource block

CONCLUSION

The article explores sustainable scheduling techniques that aim to optimize the energy, latency, and connectivity of umMTC devices on the uplink using NOMA.

- An energy-efficient algorithm was developed for resource and power allocation based on QoS. Designed to maximize EE, and connection density in NOMA uplink while minimizing link latency.

The simulation results show that

- The proposed algorithm improves the EE of umMTC UEs by up to 31% and 51% compared to the baseline schemes ESAP-NOMA and RAAP-NOMA.
- ink latency is also reduced by 3 to 10 times compared to the baseline scheme for the maximum connection density of 300 users.

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